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Worldwide Trends in Infectious Disease Research Revealed by a New Bibliometric Method

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1. Introduction

Infectious diseases cause serious public health problems and their threat has been increasing. This is because these diseases are now spreading geographically much faster than at any time in history as a result of the highly mobile, interdependent, and interconnected society (World Health Organization [WHO], 2007). In addition, it is distressing that outbreaks of emerging infectious diseases such as severe acute respiratory syndrome, Nipah virus infection, and West Nile fever have been occurring at an unprecedented rate of one or more per year in animal and human populations since the 1970s (Brown, 2004; WHO, 2007). As a recent example, the 2009 H1N1 pandemic caused by a new subtype of influenza virus inflicted damage on people around the world. Because of these reasons, infectious disease research has been promoted primarily by developed countries to provide effective countermeasures against the diseases.

Infectious disease research has become more sophisticated and diversified. For example, the identification of natural reservoirs of emerging disease pathogens requires an interdisciplinary approach among microbiology, ecology, zoology, and other fields. The risk analysis of epidemic norovirus infection requires data regarding not only the virological properties of the virus but also wastewater management and hygienic conditions. In studies on influenza in Japan, a variety of basic and applied research approaches such as analysis of pathogenesis, vaccine development, clinical investigation of prepandemic vaccines, and surveys of the route of virus transmission via migratory birds have been conducted (Figure 1) (Takahashi-Omoe & Omoe, 2009). Toward building further strategies for infectious disease research at domestic and international levels, the real trends in such studies should be grasped systematically.

As a measure to grasp trends in various research fields including infectious disease research, quantitative surveys of research articles, as an application of bibliometrics, have been conducted using scientific literature databases such as the Web of Science® (Thomson Reuters), Scopus™ (Elsevier B.V.), and PubMed (National Library of Medicine). The results of surveys provide the information needed for decision makers, public policymakers, researchers, and business leaders (Statistics Canada, 1998).

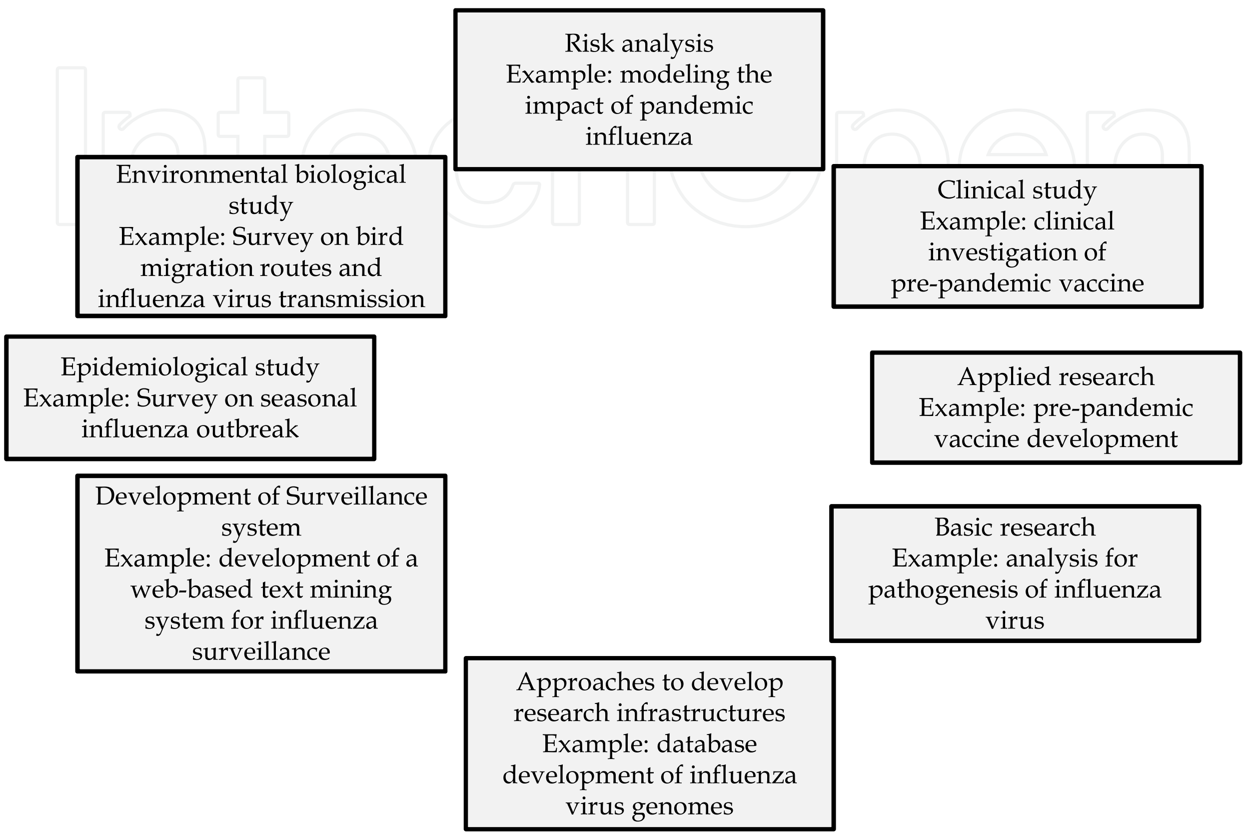

Fig. 1. An example of studies on influenza in Japan.

Regarding quantitative surveys in infectious disease research, in addition to specific diseases such as acquired immune deficiency syndrome (AIDS; caused by the human immunodeficiency virus [HIV]) (Patra & Chand, 2006; Uthman, 2008), tuberculosis (Ramos et al., 2008), and malaria (Garg et al., 2009), infectious diseases in general (Bliziotis et al., 2005; Ramos et al., 2004; Ramos et al., 2009) have been targeted. These studies demonstrated that the US, EU, and other specific world regions or nations showed a gradual increase in the publication of research articles, contributing to an increased grasp of general trends in infectious disease research in the world. However, the studies did not adequately demonstrate the real research trends in the non-English-speaking world because of limitations regarding journal selection for surveys of research articles. Previous studies were more likely to survey research articles in journals registered in the "Infectious Disease Category" of the Science Citation Index Expanded™ in the Web of Science® (the SCI Infectious Disease Category) (Thomson Reuters, 2011) and articles in international English-language journals, resulting in an underestimation of articles in non-English or regional journals that were published in the EU and Asia. Such limitations of bibliometric studies have been discussed in previous reports about the trends in infectious disease research

(Ramos et al., 2004), microbiology (Vergidis et al., 2005), and public health (Soteriades & Falagas, 2006). For example, Ramos et al. reported that European countries such as Germany, France, Italy and Spain had a long tradition of scientific publication in their own languages and might be penalized in comparative studies relying on the SCI (Ramos et al., 2004). Vergidis et al. also noted that journal selection based on the SCI particularly affected the survey results for Eastern Europe and Japan because scientists in these regions tended to publish their findings in regional journals more than scientists in others regions (Vergidis et al., 2005).

To improve on previous bibliometric analyses, we previously developed a method using 100 journals specializing in infectious disease research (infectious disease journals) (Takahashi-Omoe et al., 2009). These 100 journals, which were selected on the basis of keywords that exhaustively covered various infectious disease research fields, are published in various countries and written in various languages. Using these journals, we succeeded in surveying actual research trends in Asia between 1998 and 2006 without underestimating the number of articles in non-English and regional journals in comparison with surveys based on journals registered in the SCI Infectious Disease Category. This method using 100 journals has demonstrated the prospect for a more exhaustive survey of infectious disease research with less bias among nations and regions, although it is not perfect in comprehensiveness, similar to other bibliometric methods.

In this chapter, the features and usability of a new method using these 100 journals are being introduced, and the latest worldwide trends in infectious disease research is being presented as a practical application of the method.

2. Development of a survey method for infectious disease research

The 100 infectious disease journals used in this survey method were selected as described in section 2.1. The journals were assessed by their usability by comparison with journals registered in the SCI Infectious Disease Category as described in section 2.3.

2.1 Selection of 100 infectious disease journals

At the inception of selecting infectious disease journals, the Scopus™ database (as of 2011, the SciVerse Scopus, Elsevier B.V.; registered in January 2008) was used as a source. This is an abstract and citation database of the scientific literature that includes over 18,000 peer-reviewed journals.

On the basis of the Scopus™ database, infectious disease journals were screened using English keywords directly linked to disease control in detection, prevention, diagnosis, and medical care (A–E) (Figure 2). The keywords were chosen to select journals specifically focusing on infectious disease (A), general infectious diseases or infectious diseases belonging to specific categories (B), the field of clinical microbiology (C), the development of medicines (D), and overall technology development for disease control (E). In addition, related journals in the field of public health were selected on the basis of the author's experience (F).

In parallel, non-English journals were screened using Japanese, Chinese, French, German, Italian, Spanish, and Turkish keywords corresponding to the keywords in A–E. To screen

Korean journals, English keywords were used because almost all journal titles (89 of 91 journals) were registered in English or both English and Korean (in Roman letters) in the Scopus™ database. In the survey with English and non-English keywords, an approach based on both partial matching (for a search of journal titles that contain the keywords) and complete matching (for a search of titles that perfectly matches the keywords) was introduced to capture journal titles involving inflected forms of the keywords.

Through this screening, 264 candidates were selected, of which 240 were selected by English keywords and 24 by non-English words. The 264 journals were published in 30 countries and written in 12 languages: English, Japanese, Chinese, Korean, French, German, Italian, Spanish, Turkish, Polish, Russian, and Croatian. The list of journals can be found in our previous report (Takahashi- Omoe et al., 2009).

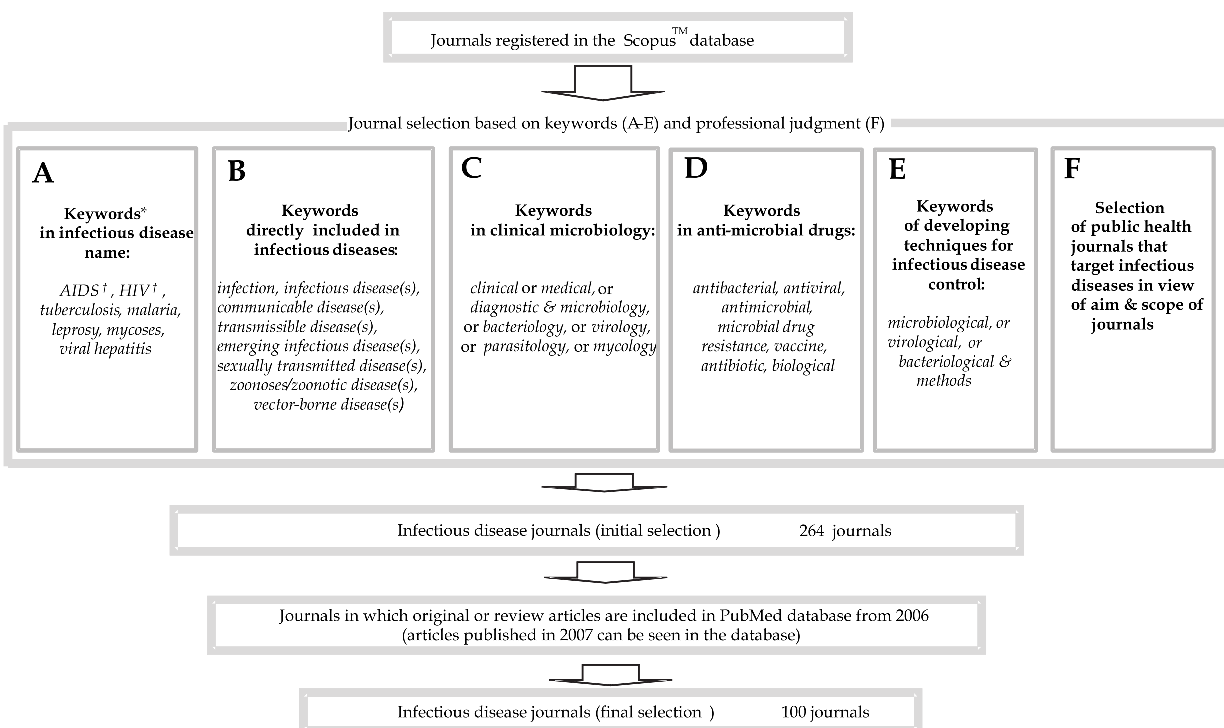

Fig. 2. Framework for selecting 100 infectious disease journals. *All keywords in A (excluding HIV); infection, infectious disease, communicable disease, sexually transmitted disease, and zoonosis in B; and antibacterial, antiviral, antimicrobial, vaccine, and antibiotic in D were translated into French, German, Italian, Spanish, Turkish, Chinese (in Roman letters), and Japanese (in Roman letters) to select journals written in non-English languages. †Journals regarding research on AIDS and HIV were selected according to the "Infectious Disease Category" of the Science Citation Index Expanded™ because several journals specializing in social-scientific and policy studies on patients could not be excluded by only the keywords "AIDS" and "HIV."

Subsequently, 100 of the 264 journals were selected on the basis of the usability of the PubMed database for indexing them. This was done to emphasize the further usability of the present survey method; the PubMed database is freely accessible and widely used, and the selected journals have continued in print through 2006 and beyond. The 100 journals listed in Table 1 were published in 18 countries and written in English and 7 non-English

AIDS	Diagnostic Microbiology and Infectious Disease	Journal of Acquired Immune Deficiency Syndromes (1999)	Malaria Journal
AIDS Patient Care and STDs	Emerging Infectious Diseases	The Japanese Journal of Antibiotics	Médecine et Maladies Infectieuses
The AIDS Reader	Enfermedades Infecciosas y Microbiología Clínica	Japanese Journal of Infectious Diseases	Medical Microbiology and Immunology
AIDS Research and Human Retroviruses	Epidemiology and Infection	Nihon Hansenby? Gakkai zasshi (Japanese Journal of Leprosy)	Medical Mycology
AIDS Reviews	European Journal of Clinical Microbiology & Infectious Diseases	Nihon Ishinkin Gakkai zasshi (Japanese Journal of Medical Mycology)	Microbes and Infection
American Journal of Infection Control	Expert Review of Vaccines	The Journal of Antibiotics	Microbial Drug Resistance
The American Journal of Tropical Medicine and Hygiene	FEMS Immunology and Medical Microbiology	The Journal of Antimicrobial Chemotherapy	Mycoses
Annals of Tropical Medicine and Parasitology	Genetic Vaccines and Therapy	Journal of Clinical Microbiology	The Pediatric Infectious Disease Journal
Antimicrobial Agents and Chemotherapy	HIV Clinical Trials	Journal of Clinical Virology	Problemy Tuberkuleza i Boleznei Legkikh
Annals of Clinical Microbiology and Antimicrobials	HIV Medicine	Journal of Communicable Diseases	Reviews in Medical Virology
Antiviral Chemistry & Chemotherapy	Human Vaccines	The Journal of Hospital Infection	Scandinavian Journal of Infectious Diseases
Antiviral Research	Indian Journal of Leprosy	Journal of Immune Based Therapies and Vaccines	Sexually Transmitted Diseases
Antiviral Therapy	Indian Journal of Medical Microbiology	The Journal of Infection	Sexually Transmitted Infections
Biologicals	Infection	Journal of Infection and Chemotherapy	Surgical Infections
BMC Infectious Diseases	Infection and Immunity	The Journal of Infectious Diseases	The Brazilian Journal of Infectious Diseases
Canada communicable disease report	Infection Control and Hospital Epidemiology	Journal of Medical Microbiology	Transplant Infectious Disease
Clinical and Vaccine Immunology	Infectious Disease Clinics of North America	Journal of Medical Virology	Travel Medicine and Infectious Disease
Clinical Infectious Diseases	Infectious Diseases in Obstetrics and Gynecology	Journal of Microbiological Methods	Tropical Medicine & International Health
Clinical Microbiology and Infection	Infectious Disorders Drug Targets	Wei mian Yu gan ran za zhi (Journal of Microbiology, Immunology, and Infection)	Tuberculosis
Clinical Microbiology Reviews	International Journal of Antimicrobial Agents	Journal of Vector-borne Diseases	Tuberkulozve Toraks
Communicable Diseases Intelligence	International Journal of Hygiene and Environmental Health	Journal of Viral Hepatitis	Vaccine
Comparative Immunology, Microbiology and Infectious Diseases	International Journal of Infectious Diseases	Journal of Virological Methods	Vector-borne and Zoonotic Diseases
Current HIV Research	International Journal of Medical Microbiology	Kansenshogakuzasshi (The Journal of the Japanese Association for Infectious Diseases)	Zhonghua jie he he hu xi za zhi (Chinese Journal of Tuberculosis and Respiratory Diseases)
Current Infectious Disease reports	International Journal of STD & AIDS	Kekkaku (Tuberculosis)	Zhonghua shi yan he lin chuang bing du xue za zhi (Chinese Journal of Experimental and Clinical Virology)
Current Opinion in Infectious Diseases	The International Journal of Tuberculosis and Lung Disease	The Lancet Infectious Diseases	
		Leprosy Review	

Table 1. List of the 100 infectious disease journals.

languages: Japanese, Chinese, French, German, Spanish, Turkish, and Russian. Forty-eight of the journals matched the journals in the SCI Infectious Disease Category. The remaining 52 journals were newly selected and included 15 Asian journals, comprising 3 journals written in Japanese, 2 in Chinese, 7 in English, and 3 in both English and Japanese or Chinese. The breakdown of the 100 journals corresponding to categories A to F is given in Figure 1: 21 were in A, 35 in B, 16 in C, 17 in D, 2 in E, and 3 in F (94 journals). Six of the journals belonged to 2 categories: 2 in A and B, 2 in B and C, 1 in B and D, and 1 in C and D.

2.2 Survey method using the 100 infectious disease journals

Using the 100 journals described in section 2.1 and the PubMed database, a method was developed to survey the actual number of research articles per infectious disease journal, publication year, and country where the first author of the article originated.

In this method, original articles and reviews were surveyed as research articles (hereafter, the term "research articles" includes both original articles and reviews); the former group was considered as an indicator of research activity, and the latter group was considered an appreciation of research results. As it was considered that highly valued scientists were given more opportunities to write reviews, meaning that their research results had attracted a good opinion and had relatively good qualities, reviews were also targeted in addition to original research articles. On the basis of the concept that the number of reviews might be indicative of research quality, the number of reviews was surveyed separately from the number of original articles.

The "Limits" function of the PubMed database was integrated into this survey method. The function contains tags for limiting the journal name (*[Jour]*), affiliation of author (*[ad]*), publication date *([PPDAT]* for print date and *[EPDAT]* for electronic publication date), and publication type (*[pt]*). Concerning the publication date, the print date for journals that had both print and electronic versions was prioritized. Detailed information whether each infectious disease journal was surveyed on the basis of the print publication date or electronic publication date can be found in our previous report (Takahashi-Omoe et al., 2009).

For example, the following text to search for research articles published on "*AIDS*" during 2006 and first author of which lived in Japan was applied: *AIDS [Jour] AND journal article [pt] AND Japan [ad] AND 2006 [PPDAT]*.

2.3 Usability of the survey method

2.3.1 Method of usability analysis

To ascertain whether the 100 newly selected journals could survey a wide range of infectious disease research articles, the 100 journals and the journals of the SCI Infectious Disease Category were compared from the viewpoint of the difference in the proportion of Asian research articles relative to the world total. A usability analysis of the 100 journals intended for Asian articles was appropriate because research articles in non-English or regional journals published in the EU and Asia tend to be underestimated as described in the "Introduction."

The actual number of research articles in the 100 journals in 1998–2006 was surveyed using the PubMed database. The target Asian countries were Japan, China, India, Taiwan, Korea, Singapore, Malaysia, Indonesia, Vietnam, Thailand, and the Philippines. The world total number of articles was also surveyed. Articles registered in the SCI category were surveyed in a manner similar to those in the 100 journals.

2.3.2 Results of the usability analysis

Concerning the proportion of Asian articles relative to the world total, it was revealed that a survey of the 100 journals revealed a consistently higher percentage than the SCI Infectious Disease Category in 1998–2006. The total number of Asian research articles accounted for 12% of the world total in the survey of the 100 journals (actual numbers of Asian and worldwide research articles were 14,156 and 118,158, respectively, as described in this paragraph) (Table 2) and 6.9% in the survey of SCI Infectious Disease Category (4,621 and 66,518, respectively) (Table 3). Each year during the study period, the proportion of original articles of Asian origin relative to the world total was approximately 8.6%–14.2% in the 100 journals and 4.7%–9.3% in the SCI category, and that of reviews of Asian origin was approximately 4.2%–6.9% in the 100 journals and 1.0%–3.9% in the SCI category (Table 2 and 3).

From these findings, it was demonstrated that a survey method using the 100 journals could identify more research articles and avoid underestimation of the numbers of articles in regional and non-English journals. Therefore, this method was considered beneficial to grasp the overall trends in infectious disease research in comparison with previous bibliometric studies based on journals registered in the SCI Infectious Disease Category.

Year/original articles or reviews	**1998/ OR**	**1998/ RV**	**1999/ OR**	**1999/ RV**	**2000/ OR**	**2000/ RV**	**2001/ OR**	**2001/ RV**	**2002/ OR**	**2002/ RV**
Total number of articles in Asian countries	830	48	1079	54	1330	60	1389	74	1516	66
Total number of articles in the world	9,661	1,013	10,430	1,237	10,764	1,442	10,919	1,484	11,032	1,405
Proportion of Asian articles relative to the world total (%)	8.6	4.7	10.3	4.4	12.4	4.2	12.7	5.0	13.7	4.7

Year/original articles or reviews	**2003/ OR**	**2003/ RV**	**2004/ OR**	**2004/ RV**	**2005/ OR**	**2005/ RV**	**2006/ OR**	**2006/ RV**	**1998-2006/ OR**	**1998-2006/ RV**	**1998-2006/ OR+RV**
Total number of articles in Asian countries	1605	107	1825	96	1847	99	2010	105	13452	705	14156
Total number of articles in the world	12,239	1,584	12,896	1,580	13,246	1,580	14,121	1,525	105,308	12,850	118,158
Proportion of Asian articles relative to the world total (%)	13.1	6.8	14.2	6.1	13.9	6.3	14.2	6.9	12.8	5.5	12.0

Table 2. Total number of articles in Asian countries and the world, and the proportion of Asian articles relative to the world total in 100 infectious disease journals in 1998–2006. OR is original articles, and RV is reviews.

Year/original articles or reviews	1998/ OR	1998/ RV	1999/ OR	1999/ RV	2000/ OR	2000/ RV	2001/ OR	2001/ RV	2002/ OR	2002/ RV	
Total number of articles in Asian countries	259	7	365	14	438	20	450	25	472	28	
Total number of articles in the world	5,489	697	5,847	805	6,256	919	6,262	976	6,243	864	
Proportion of Asian articles relative to the world total (%)	4.7	1.0	6.2	1.7	7.0	2.2	7.2	2.6	7.6	3.2	
Year/original articles or reviews	2003/ OR	2003/ RV	2004/ OR	2004/ RV	2005/ OR	2005/ RV	2006/ OR	2006/ RV	1998-2006/ OR	1998-2006/ RV	1998-2006/ OR+RV
Total number of articles in Asian countries	480	26	617	38	629	33	698	21	4,412	209	4,621
Total number of articles in the world	6,615	932	7,039	981	7,163	1,043	7,510	877	58,424	8,094	66,518
Proportion of Asian articles relative to the world total (%)	7.3	2.8	8.8	3.9	8.8	3.2	9.3	2.4	7.6	2.6	6.9

Table 3. Total number of articles in Asian countries and the world, and the proportion of Asian articles relative to the world total in the SCI Infectious Disease Category during 1998–2006. OR is original articles, and RV is reviews.

3. Worldwide trends in infectious disease research

As the method using 100 infectious disease journals was demonstrated to be beneficial as described in section 2.3.2, worldwide trends in infectious disease research were subsequently surveyed using the method.

3.1 Survey method

The number of research articles in the 100 infectious disease journals in 2001–2010 was surveyed on country-by-country and year-by-year bases and analyzed for relative comparisons among countries, yearly change, and the relationship between socioeconomic as well as science and technology factors.

Specifically, in a similar manner as described in section 2.2, the actual number of research articles was surveyed using the “Limits” function of the PubMed database. The targeted countries were the US, EU countries (the UK, France, Germany, Italy, Spain, and the Netherlands), and Asian countries (Japan, China, and India). These 6 EU and 3 Asian countries were selected on the basis of the higher production of infectious disease research articles in the areas, which has been previously reported (the EU and Asian top countries) (Ramos et al., 2009; Takahashi-Omoe et al., 2009). In addition, the US was reported to produce the most articles in the SCI Infectious Disease Category in 1995–2002 (Bliziotis et al., 2005). Therefore, a survey for these 10 countries was considered appropriate to grasp the worldwide trends in infectious disease research.

In the case of the UK, articles from England, Wales, Scotland, and Northern Ireland were grouped together, and the following limitation was set in the affiliation field of the PubMed database: UK[ad] OR United Kingdom[ad] OR Great Britain[ad] OR (England[ad] NOT New England[ad]) OR (Wales[ad] NOT New South Wales[ad]) OR Scotland [ad] OR (N Ireland[ad] OR Northern Ireland[ad]). For example, the following text was applied to search for research articles published on "*AIDS*" in 2010 and the first author of which lived in the UK: *AIDS [Jour] AND journal article [pt] AND (UK[ad] OR United Kingdom[ad] OR Great Britain[ad] OR (England[ad] NOT New England[ad]) OR (Wales[ad] NOT New South Wales[ad]) OR Scotland [ad] OR (N Ireland[ad] OR Northern Ireland[ad])) AND 2010 [PPDAT].*

As a further analysis of worldwide trends, the number of research articles registered in the 100 journals in 2001–2010 was weighted according to socioeconomic factors (the population and gross domestic product [GDP]) and science and technology factors (the number of researchers in research and development [R&D] and health expenditure per capita) of each country. Annual data for the population, GDP, number of researchers in R&D, and health expenditure of 10 countries were obtained from the World Bank. Detailed information about these socioeconomic and science and technology factors can be found in the World Bank database (The World Bank, 2011). Specifically, researchers in R&D are defined as professionals engaged in the conception or creation of new knowledge, products, processes, methods, or systems and in the management of the projects concerned, including postgraduate PhD students engaged in R&D. Health expenditure is derived from a sum of public and private health expenditures as a ratio of total population and covered the provision of health services (preventive and curative), family planning activities, nutrition activities, and emergency aid designated for health but did not include provision of water and sanitation.

Using the non-parametric correlation statistical test (Spearman's Rank Correlation test), the numbers of research articles were analyzed in relation to the socioeconomic and science and technology factors. Statistical analyses were performed using SPSS Statistics (version 17.0; SPSS Japan Inc., Tokyo, Japan).

3.2 Survey result

3.2.1 Leading countries in the number of research articles

The total number of infectious disease research articles throughout the world in the 100 infectious disease journals was 148,435 in 2001–2010 (Table 4). Among 10 countries, the US published the most infectious disease research articles (41,055 articles, 27.7% of the world total). This total far outpaced that of the second leading country, the UK (10,893 articles, 7.3%). France and Japan were the third and fourth most productive countries (7,711 [5.2%] and 7,582 articles [5.1%], respectively).

When original articles and reviews were viewed separately, the US remained the top country in terms of research article production, being responsible for 26.8% and 34.9% of original articles and reviews in the world, respectively (Table 5). The UK was a distant second, publishing 6.9% of original articles and 11.1% of reviews. Japan had a relatively higher percentage of original articles (5.4%) and was third in productivity, followed by France (5.2% of original articles). Interestingly, Spain and China produced an equal percentage of original articles (3.5%). Regarding reviews, it was remarkable that Asian countries had relatively lower percentages than the EU countries. In particular, the number of reviews originating from China totaled 118, which was 0.7% of the world total and the lowest proportion among the 10 countries.

At the domestic level, the proportion of reviews among the total number of articles was highest in the UK (16.4%), followed by the US (13.7%) and Germany (12.2%). Five EU countries had proportions exceeding 10%, whereas all 3 Asian countries had proportions less than 10%, including Japan (6.6%).

Countries	Original articles	Reviews	Original articles & reviews
World	132,282	16,153	148,435
US	35,425	5,630	41,055
UK	9,106	1,787	10,893
France	6,884	827	7,711
Germany	5,457	756	6,213
Italy	4,129	484	4,613
Spain	4,587	464	5,051
The Netherland	3,172	353	3,525
Japan	7,081	501	7,582
China	4,618	118	4,736
India	3,337	187	3,524

Table 4. Total number of research articles originating from the US, EU, and Asian countries in 100 infectious disease journals in 2001–2010. The numeric data show the number of original articles and reviews.

	Relative to the domestic total number		Relative to the total number of OR, RV, or OR+RV of the world		
	OR /OR+RV	RV /OR+RV	OR/OR	RV/RV	OR+RV /OR+RV
US	86.3	13.7	26.8	34.9	27.7
UK	83.6	16.4	6.9	11.1	7.3
France	89.3	10.7	5.2	5.1	5.2
Germany	87.8	12.2	4.1	4.7	4.2
Italy	89.5	10.5	3.1	3.0	3.1
Spain	90.8	9.2	3.5	2.9	3.4
The Netherlands	90.0	10.0	2.4	2.2	2.4
Japan	93.4	6.6	5.4	3.1	5.1
China	97.5	2.5	3.5	0.7	3.2
India	94.7	5.3	2.5	1.2	2.4

Table 5. Relative comparison of the number of articles originating from the US, EU, and Asian countries in 100 infectious disease journals in 2001–2010. The numeric data indicate percentages. OR: original articles, RV: reviews.

3.2.2 Yearly change in the number of research articles

As shown in Figure 3, the number of original articles across the world increased from 2001 to 2010. By contrast, the numbers from the US and the UK did not remarkably change, regardless of their high numbers. The increase in the total number of original articles across the world resulted from the increase in articles from China as shown in Fig. 4, or perhaps other countries that were not surveyed in this study.

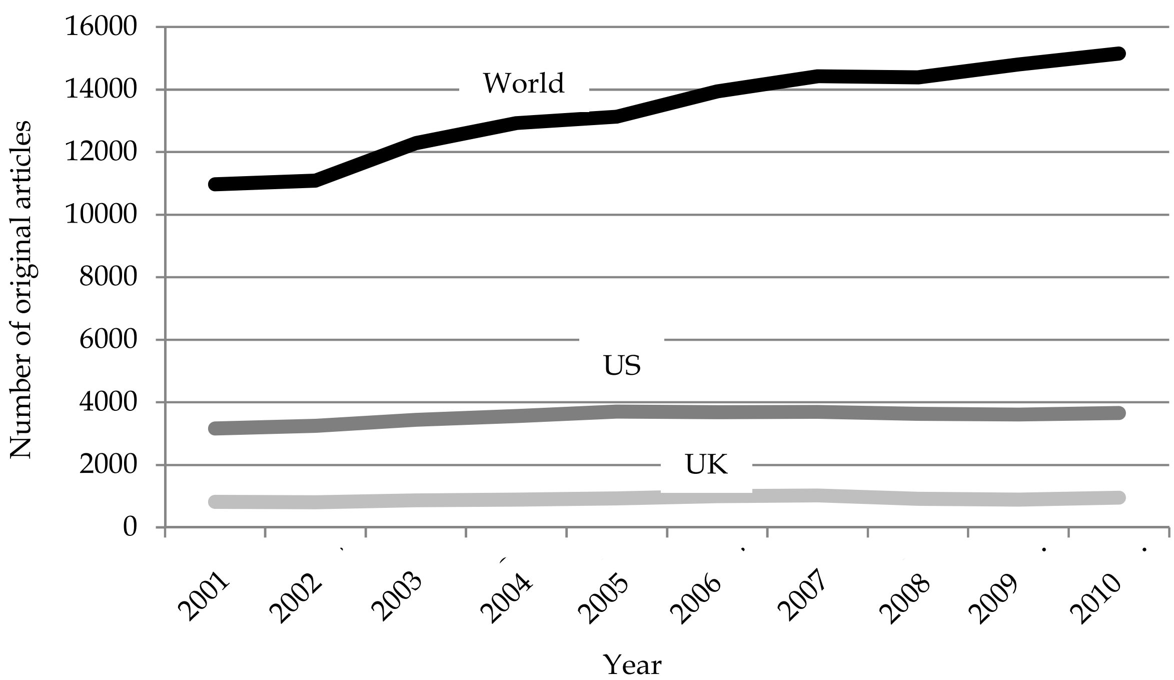

Fig. 3. Number of original articles in 100 infectious disease journals originating from the world, US, and UK in 2001–2010.

As noted previously, the number of original articles originating from China remarkably increased during this same period (Figure 4). The number in 2010 was more than 3-fold higher than that in 2001, including remarkable growth in the number of articles over the last 5–6 years. The concrete number of original articles from China exceeded that from Germany in 2008 (616 vs. 539 articles), Japan in 2009 (733 vs. 711 articles), and France in 2010 (809 vs. 764 articles).

Concerning the number of reviews, no noticeable increase was revealed in the world or the US and UK totals during the study period (Figure 5). The number from France showed a 2-fold increase in 2002–2006, but a slight decline since 2007. By contrast, the numbers from China and India remarkably increased from 2001 to 2010 (approximately 8.3-fold and 5.7-fold), but their numbers were lower than other countries (Figure 6). In addition, the number from Italy relatively increased among 10 countries (approximately 2.3-fold).

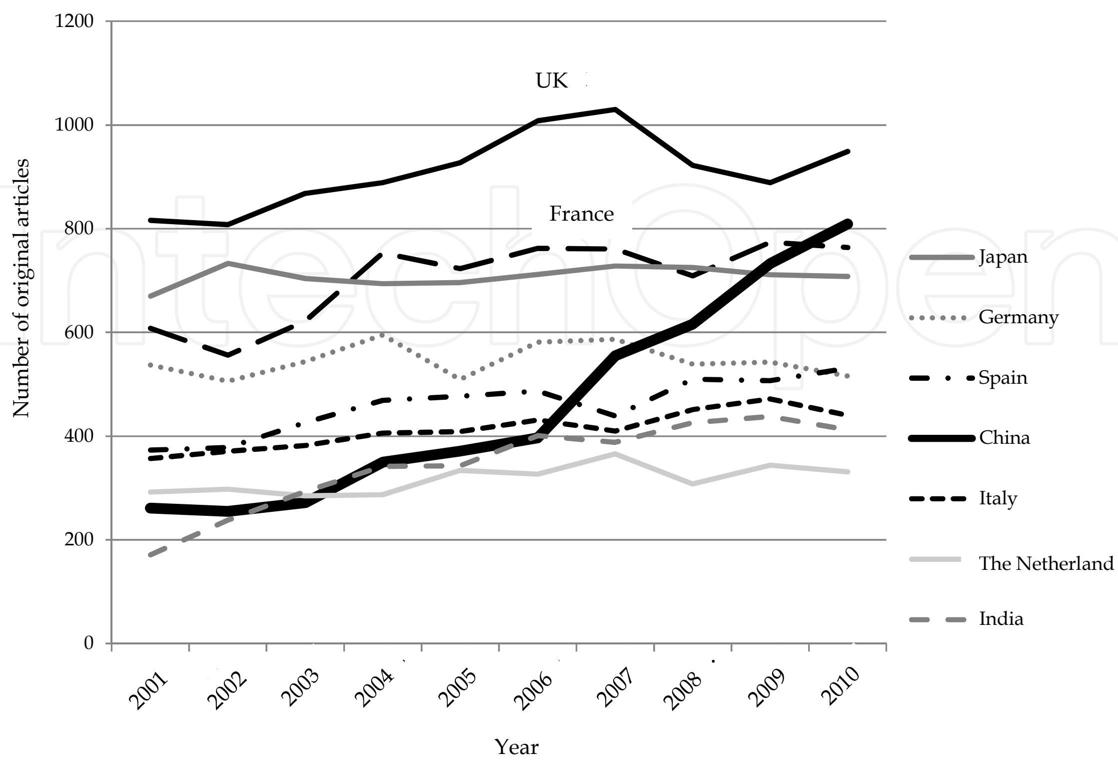

Fig. 4. Number of original articles in 100 infectious disease journals originating from the EU and Asian countries in 2001–2010.

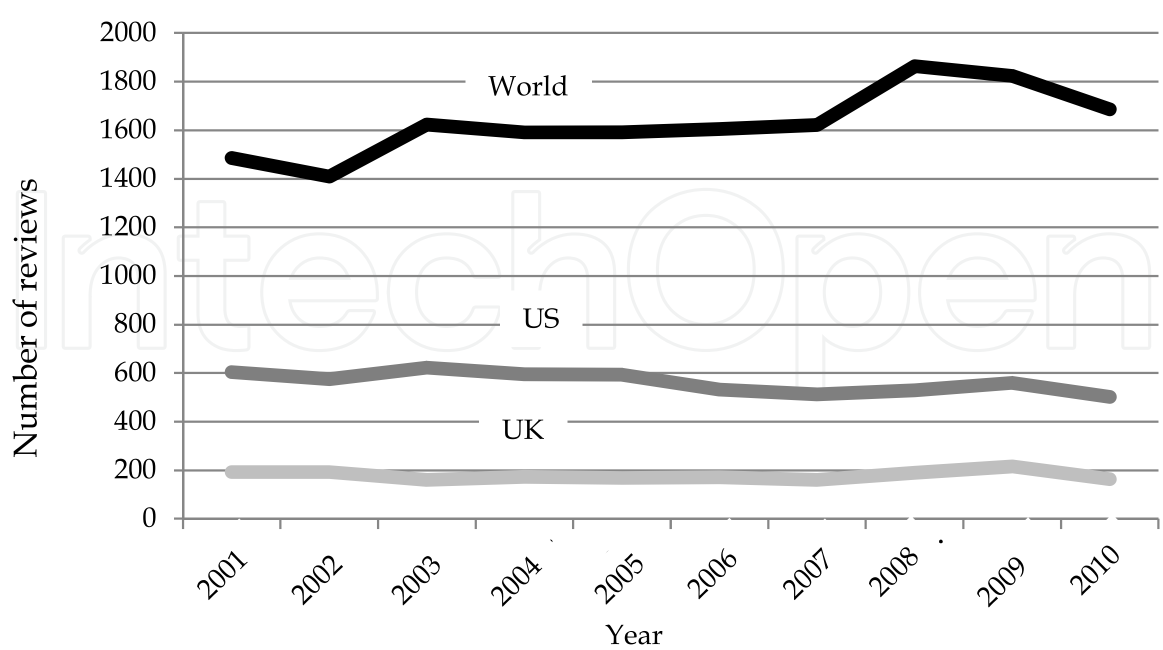

Fig. 5. Number of reviews in 100 infectious disease journals originating from the world, US, and UK in 2001–2010.

Fig. 6. Number of reviews in 100 infectious disease journals originating from the EU and Asian countries in 2001–2010.

3.2.3 Research productivity from the socioeconomic viewpoint

As a further analysis of publications of infectious disease research, the number of research articles was compared among 10 countries in terms of socioeconomic factors, the population, and GDP of each country.

Regarding the population, the ratio of the number of original articles to the population of individual countries exhibited a median value of 9 publications/1 million population/year (range, 0.3–19.3) in 2001–2009. Using population-adjusted ratios, the Netherlands (median value of 19.3) and the UK (14.9) were the most productive countries (Figure 7). The ratio of the number of reviews exhibited a median value of 0.9 publications/1 million population/year (range, 0–2.8). Using population-adjusted ratios, the UK ranked first (2.8), followed by the Netherlands (2.0) and the US (1.9). No statistically significant correlation were found between the average population and the number of original articles (Spearman's correlation coefficient = 0.213, p = 0.554) or reviews (Spearman's correlation coefficient = −0.097, p = 0.789) in the 10 countries in 2001–2009.

Regarding the ratio of the number of original articles to the GDP, the median value was 3.2 publications/10 billion GDP/year (range, 1.5–4.8) in 2001–2009. According to GDP-adjusted ratios for original articles, the Netherlands (4.8), India (4.2), and the UK (4.1) were highly productive (Figure 8). The ratio of the number of reviews exhibited a median value of 0.4 publications/10 billion GDP/year (range, 0–0.8) in 2001–2009. According to GDP-adjusted ratios for reviews, the UK (0.8) and the Netherlands (0.5) were most productive. A statistical correlation was found between the average GDP and the number of original articles (Spearman's correlation coefficient = 0.778, p = 0.008), but no statistically significant correlation between the average GDP and the number of reviews was observed (Spearman's correlation coefficient = 0.576, p = 0.082) in the 10 countries.

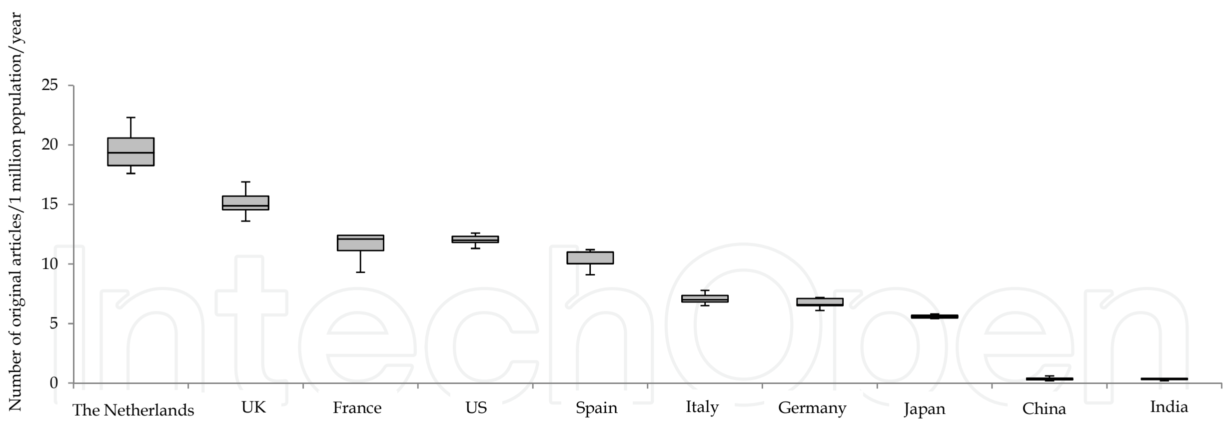

Fig. 7. Publication of original articles in 100 infectious disease journals by population in 2001–2009. Upper horizontal lines, dots, and lower horizontal lines in the boxes represent the first, second (median), and third quartiles, respectively. Whiskers represent the extension of values up and down.

In summary, we demonstrated that the Netherlands and the UK were most productive among the 10 countries when adjusting the production of original articles and reviews according to socioeconomic factors such as the population and GDP of each country.

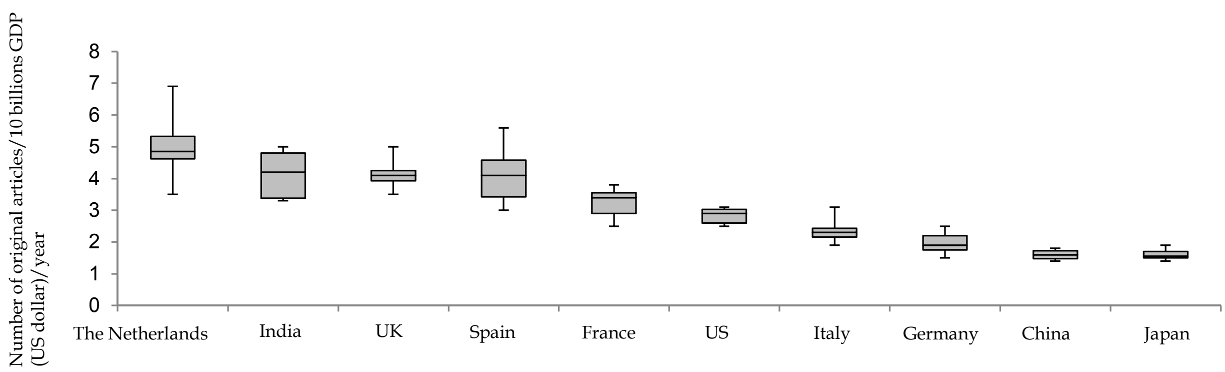

Fig. 8. Publication of original articles in 100 infectious disease journals by GDP in 2001–2009. Upper horizontal lines, dots, and lower horizontal lines in the boxes represent the first, second (median), and third quartiles, respectively. Whiskers represent extension of values up and down.

3.2.4 Research productivity from the science and technology viewpoint

In addition to socioeconomic factors, science and technology factors, represented by the number of researchers in R&D and health expenditure per capita, were applied to analyze the research productivity of each country.

The ratio of the number of original articles to the number of researchers in R&D exhibited a median value of 0.3 publications/number of researchers per 100 thousand people/year (range, 25.1–1.2) in 2001–2007. Using the number of researchers-adjusted ratios, India (median value of 25.1) was the most productive country (Figure 9). The ratio of the number of reviews exhibited a median value of 0.3 publications/number of researchers per 100 thousand people/year (range, 0.1–1.4) in 2001–2007. When adjusting the production of reviews according to the number of researchers, India ranked first (1.4), followed by the US (1.3). There were statistically significant correlations between the average number of researchers and original articles (Spearman's correlation coefficient = 0.802, p = 0.005) and reviews (Spearman's correlation coefficient = 0.806, p = 0.005) in the 10 countries in 2001–2007.

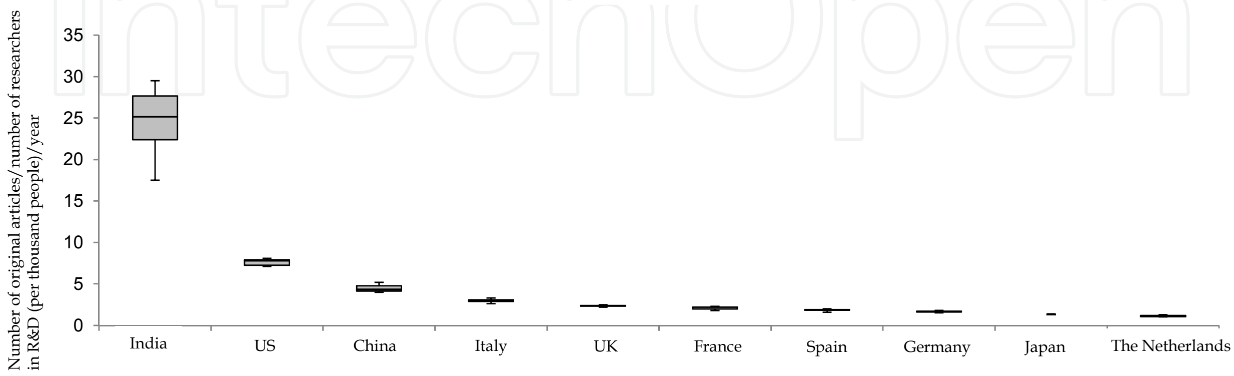

Fig. 9. Publication of original articles in 100 infectious disease journals according to the number of researchers in R&D in 2001–2007. Upper horizontal lines, dots, and lower horizontal lines in the boxes represent the first, second (median), and third quartiles, respectively. Whiskers represent the extension of values up and down. The survey period was 2001–2007 because data for the 10 countries were not fully gained from the World Bank data source in 2008–2009.

Concerning the ratio of the number of original articles to the health expenditure per capita, the median value was 2.3 publications/10 dollars health expenditure per capita/year (range, 0.8–113.2). For health expenditure-adjusted ratios, India (113.2) and China (45.5) were highly productive (Figure 10).

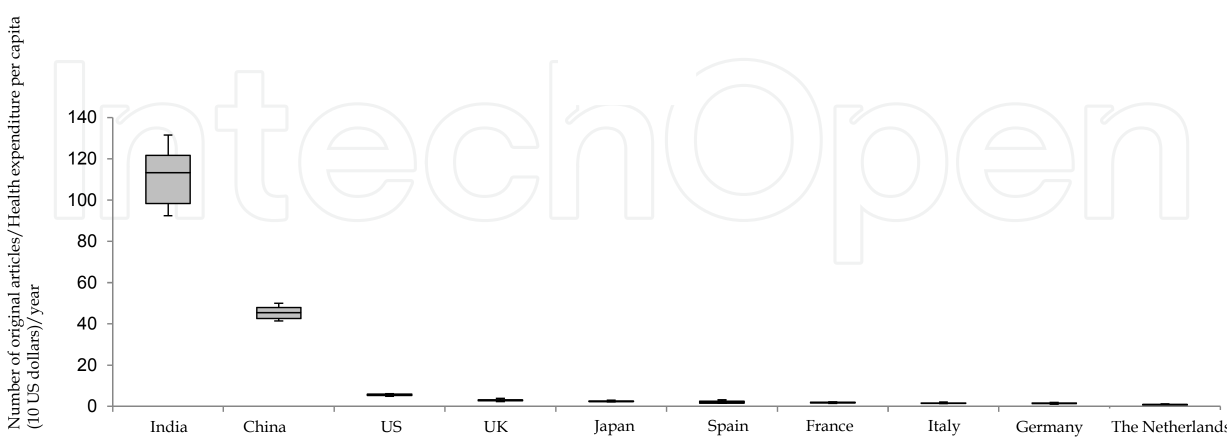

Fig. 10. Publication of original articles in 100 infectious disease journals according to health expenditure per capita in 2001–2009. Upper horizontal lines, dots, and lower horizontal lines in the boxes represent the first, second (median), and third quartiles, respectively. Whiskers represent the extension of values up and down.

The ratio of the number of reviews exhibited a median value of 0.2 publications/10 dollars health expenditure per capita/year (range, 0.1–6.3). When adjusting the production of reviews according to the health expenditure per capita, India (6.3) and China (1.2) were the most productive countries. There was no statistical correlation between the average of the health expenditure per capita and the number of original articles (Spearman's correlation coefficient = 0.407, $p = 0.243$), but a statistical correlation between the average of the health expenditure per capita and the number of reviews was observed (Spearman's correlation coefficient = 0.697, $p = 0.025$) for the 10 countries.

Generally, India was the most productive according to science and technology factors such as the number of researchers and health expenditure of each country. The US and China were ranked in the top three for both researcher- and health expenditure-adjusted ratios.

3.3 General overview of worldwide trends in infectious disease research

Through a bibliometric analysis using the 100 infectious disease journals described previously, 5 features were highlighted as the worldwide research trends in 2001–2010.

3.3.1 Vigorous infectious disease research around the world

We demonstrated that increasing numbers of infectious disease research articles were published around the world. This result was similar to previous bibliometric data reported by Bliziotis et al., although their study targeted journals registered in the SCI Infectious Disease Category and published in 1995–2002 (Bliziotis et al., 2005). It can be said that infectious disease research has been evidently vigorous without the influence of survey methods.

3.3.2 US as the leading country in infectious disease research

Our survey demonstrated that the US was the leading country in infectious disease research, as the US produced the highest percentage of total research articles (27.7% of the world total). The UK ranked second (7.3% of the world), but its output was dwarfed by that of the US. Ramos et al. also reported these 2 countries as the leading countries (Ramos et al., 2009) based on their study on journals registered in the SCI Infectious Disease Category covering the period of 2002–2007 (Bliziotis et al., 2005). These results from surveys based on 100 infectious journals and journals in the SCI Infectious Disease Category demonstrated that the US and the UK had an undisputed lead in infectious disease research productivity.

3.3.3 The Netherlands, India, and China as productive countries in the field of infectious disease research according to socioeconomic and science and technology factors

The US and the UK dominated the field of infectious disease research according to the global share of research articles, but the Netherlands, India, and China were considered productive countries when adjusting the production of original articles for socioeconomic factors and science and technology factors.

3.3.4 Developing infectious disease research in China

According to our findings, the productivity of infectious disease research in terms of a noticeable increase in the number of produced original articles was observed for China.

Significantly, China overtook France and Japan regarding the number of original articles in 2010 and 2009, respectively. However, China had the lowest proportion of reviews among the 10 countries. This trend might indicate that infectious disease research in China was developing and that it has not come to be well recognized.

3.3.5 More appreciated outputs of infectious disease research from the US and the top EU countries

Through this method, it became clear that the US and the top EU countries produced relatively higher proportions of reviews than the top Asian countries. Even Japan, which produced the most research articles in Asia, produced fewer reviews than the UK, France, and Germany. It could be speculated that the research output from the US and the top EU countries was more appreciated than those from top Asian countries.

4. Conclusion

This chapter presented the recent worldwide trends in infectious disease research as a practical application of a method using 100 infectious disease journals. The trends in 2001–2010 included vigorous research, with the US and the UK being the most active countries. Given the research productivity based on socioeconomic and science and technology factors, the Netherlands, India, and China had relatively high productivity. The developing research in China and more appreciated research outputs from the top EU countries were also significant. Based on these survey results, further content analysis of infectious disease research articles may be necessary to build future research strategies for effective disease control.

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6. References

Bliziotis, I.A.; Paraschakis, K.; Vergidis, P.I.; Karavasiou, A.I. & Falagas, M.E. (2005).
Worldwide trends in quantity and quality of published articles in the field of infectious diseases. *BMC Infectious Diseases*, Vol.5, No.16, ISSN 1471-2334

Brown, C. (2004). Emerging zoonoses and pathogens of public health significance–an overview. *Revue scientifique et technique (International Office of Epizootics)*, Vol.23, No.2, pp. 435-42, ISSN 0253-1933

Elsevier B.V. (2011). SciVerse Scopus, Available from http://www.info.sciverse.com/scopus/about

Garg, K.C.; Kumar, S.; Madhavi, Y. & Bahl, M. (2009). Bibliometrics of global malaria vaccine research. *Health Information and Libraries Journal* Vol.26, pp.22-31, ISSN 1471-1834

Patra, S.K. & Chand, P. (2007). HIV/AIDS research in India: A bibliometric study. *Library & Information Science Research* Vol.29, pp.124-134, ISSN 0740-8188

Ramos, J.M.; Gutiérrez, F.; Masía, M. & Martín-Hidalgo, A. (2004). Publication of European union research on infectious diseases (1991-2001): A bibliometric evaluation.

European Journal of Clinical Microbiology & Infectious Diseases, Vol.23, pp.180-184, ISSN 0934-9723

Ramos, J.M.; Masía, M.; Padilla, S. & Gutiérrez, F. (2009). A bibliometric overview of infectious diseases research in European countries (2002-2007). *European Journal of Clinical Microbiology & Infectious Diseases*, Vol.28, pp.713-716, ISSN 0934-9723

Ramos, J.M.; Padilla, S.; Masía, M. & Gutiérrez, F. (2008). A bibliometric analysis of tuberculosis research indexed in PubMed, 1997-2006. *International Journal of Tuberculosis and Lung Disease*, Vol.12, pp.1461-1468, ISSN 1027-3719

Soteriades, E.S. & Falagas M.E. (2006). A bibliometric analysis in the fields of preventive medicine, occupational and environmental medicine, epidemiology, and public health. *BMC Public Health*, Vol.6, No.301, ISSN 1471-2458

Statistics Canada (1998). *Bibliometric analysis of scientific and technological research: A user's guide to the methodology*, Canada, Available from http://www.statcan.gc.ca/pub/88f0006x/88f0006x1998008-eng.pdf

Takahashi-Omoe, H. & Omoe, K. (2009). Regulatory and scientific framework for zoonosis control in Japan–contributing to International Health Regulations (2005). *Revue scientifique et technique (International Office of Epizootics)*,Vol.28, pp.957-973, ISSN 0253-1933

Takahashi-Omoe, H.; Omoe, K. & Okabe, N. (2009). New journal selection for quantitative survey of infectious disease research: application for Asian trend analysis. *BMC Medical Research Methodology*, Vol.9, No.67, ISSN 1471-2288

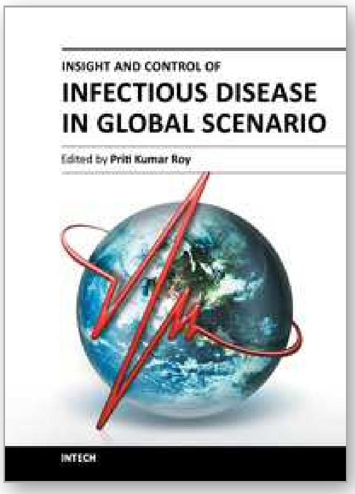
Thomson Reuters (2011). Science Sitation Index Expanded, Available from http://science.thomsonreuters.com/cgi-bin/jrnlst/jloptions.cgi?PC=D

Uthman, O.A. (2008). HIV/AIDS in Nigeria: a bibliometric analysis. *BMC Infectious Diseases*, Vol. 8, No.19, ISSN 1471-2334

Vergidis, P.I.; Karavasiou, A.I.; Paraschakis, K.; Bliziotis, I.A.; Falagas M.E. (2005). Bibliometric analysis of global trends for research productivity in microbiology. *European Journal of Clinical Microbiology & Infectious Diseases*, Vol. 24, pp.342-345, ISSN 0934-9723

World Bank. (2011). Data, Inficators, Available from http://data.worldbank.org/indicator

World Health Organization. (2007). *The World Health Report 2007, A Safer Future: Global Public Health Security in the 21st Century*, Geneva, Switzerland, Available from http://www.who.int/whr/2007/whr07_en.pdf



Insight and Control of Infectious Disease in Global Scenario
Edited by Dr. Roy Priti

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This book is projected as a preliminary manuscript in Infectious Disease. It is undertaken to cover the foremost basic features of the articles. Infectious Disease and analogous phenomenon have been one of the main imperative postwar accomplishments in the world. The book expects to provide its reader, who does not make believe to be a proficient mathematician, an extensive preamble to the field of infectious disease. It may immeasurably assist the Scientists and Research Scholars for continuing their investigate workings on this discipline. Numerous productive and precise illustrated descriptions with a number of analyses have been included. The book offers a smooth and continuing evolution from the principally disease oriented lessons to a logical advance, providing the researchers with a compact groundwork for upcoming studies in this subject.

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